

CLAIMS

What is claimed is:

1. In a plasma processing system, a method etching a substrate, said substrate having a semi-conductor layer, a first barrier layer disposed above said semi-conductor layer, a low-k layer disposed above said first barrier layer, a third hard mask layer disposed above said low-k layer; a second hard mask layer disposed above said third hard mask layer, and a first hard mask layer disposed above said second hard mask layer, comprising:

alternatively etching said substrate with a first etchant and a second etchant, wherein said first etchant has a low selectivity to a first hard mask material of said first hard mask layer, a third hard mask material of said a third hard mask layer, and a first barrier layer material of said first barrier layer, but a high selectivity to a second hard mask material of said second hard mask layer, and

wherein said second etchant has a high selectivity to said first hard mask material of said first hard mask layer, said third hard mask material of said third hard mask layer, and said first barrier layer material of said first barrier layer, and said first etchant has a low selectivity to said second hard mask material of said second hard mask layer.

2. The method of claim 1, wherein said alternatively etching includes etching partially through said low-k layer with said second etchant.

3. The method of claim 2, wherein said alternatively etching includes etching partially through said first barrier layer with said second etchant.

4. The method of claim 3 wherein said alternatively etching includes substantially removing said first hard mask material.

5. The method of claim 1, further including a second barrier layer, comprised of a second barrier material, is disposed between said third hard mask layer and said low-k layer, whereas said second etchant has a low selectivity to said second barrier material, and said first etchant has a high selectivity to said second barrier material.

6. The method of claim 5, wherein said alternatively etching includes etching partially

through said second barrier layer with said second etchant.

7. The method of claim 6, wherein said second etchant etches at least a portion of said second hard mask layer, said low-k layer, and said second barrier layer substantially simultaneously.
8. The method of claim 1, wherein said first hard mask material, said second hard mask material, and said third hard mask material are lithographically patterned for a dual-damascene manufacturing method.
9. The method of claim 1, wherein said first hard mask material is SiN.
10. The method of claim 1, wherein said first hard mask material is SiC.
11. The method of claim 1, wherein said second hard mask material is TEOS.
12. The method of claim 1, wherein said third hard mask material is SiN.
13. The method of claim 1, wherein said third hard mask material is SiC.
14. The method of claim 1, wherein said first barrier layer is SiN.
15. The method of claim 1, wherein said first barrier layer is SiC.
16. The method of claim 2, wherein said second barrier layer is TEOS.
17. The method of claim 1, wherein first etchant is CF₄.
18. The method of claim 1, wherein first etchant is CHF₃.
19. The method of claim 1, wherein second etchant is C₄F₆.

20. The method of claim 1, wherein second etchant is C_4F_8 .

21. In a plasma processing system, a method etching a substrate, said substrate having a semi-conductor layer, a first barrier layer disposed above the semi-conductor layer, a low-k layer disposed above the first barrier layer, a second barrier layer disposed above the low-k layer, a third hard mask layer disposed above the second barrier layer, a second hard mask layer disposed above the third hard mask layer, and a first hard mask layer disposed above the second hard mask layer, comprising:

alternatively etching said substrate with a first etchant and a second etchant, wherein said first etchant has a low selectivity to a first hard mask material of said first hard mask layer, a third hard mask material of said a third hard mask layer, and a first barrier layer material of said first barrier layer, but a high selectivity to a second hard mask material of said second hard mask layer, and

wherein said second etchant has a high selectivity to said first hard mask material of said first hard mask layer, said third hard mask material of said third hard mask layer, and said first barrier layer material of said first barrier layer, and said first etchant has a low selectivity to said second hard mask material of said second hard mask layer and said second barrier layer.

22. The method of claim 21, wherein said alternatively etching includes etching partially through said low-k layer with said second etchant.

23. The method of claim 22, wherein said alternatively etching includes etching partially through said first barrier layer with said second etchant.

24. The method of claim 23 wherein said alternatively etching includes substantially removing said first hard mask material.

25. The method of claim 21, wherein said alternatively etching includes etching partially through said second barrier layer with said second etchant.

26. The method of claim 21, wherein said second etchant etches at least a portion of said

second hard mask layer, said low-k layer, and said second barrier layer substantially simultaneously.

27. The method of claim 21, wherein said first hard mask material, said second hard mask material, and said third hard mask material are lithographically patterned for a dual-damascene manufacturing method.

28. The method of claim 21, wherein said first hard mask material is SiN.

29. The method of claim 21, wherein said first hard mask material is SiC.

30. The method of claim 21, wherein said second hard mask material is TEOS.

31. The method of claim 21, wherein said third hard mask material is SiN.

32. The method of claim 21, wherein said third hard mask material is SiC.

33. The method of claim 21, wherein said first barrier layer is SiN.

34. The method of claim 21, wherein said first barrier layer is SiC.

35. The method of claim 22, wherein said second barrier layer is TEOS.

36. The method of claim 21, wherein first etchant is CF₄.

37. The method of claim 21, wherein first etchant is CHF₃.

38. The method of claim 21, wherein second etchant is C₄F₆.

39. The method of claim 21, wherein second etchant is C₄F₈.